AMENDED CLAIMS

[received by the International Bureau on 12 August 2004 (12.08.04);
original claims 1 to 53 are replaced by new claims 1 to 54] (10 pages)

1.   A method for estimating the fibre fineness of a
known mass of fibres, the method including the steps of:
    a)   capturing with an image capturing device either
i) all of the fibres being tested in one or more images or
ii) a fraction of the fibres being tested in one or more
images;
    b)   determining the total length of the fibre or
fibres in the or each image using automated computer image
analysis; and
    c)   estimating the fibre fineness of the sample of
fibres using the total fibre length in the image(s).

2.   The method according to claim 1, further
including estimating the total length of fibre in the
sample by multiplying a mean length of fibre in the images
determined in step b) by a ratio representing the total
fibre in the sample to the average portion of fibre in the
images.

3.   The method according to claim 2, wherein step c)
involves dividing the known mass of fibre by the total
length of fibre.

4.   The method according to any one of claims 2 to 3
whereby when step a) involves capturing a series of images
that overlap, step b) involves taking into account the
length of fibre in an overlapping section of the images to
avoid over estimating the total length of fibre.

5.   The method according to any one of claims 2 to 4,
wherein the image capturing device is a digital camera, an
analogue camera or a CCD camera.

6.   The method according to any one of claims 2 to 5,
wherein the sample of fibres is dispersed on a viewing

platform and relative movement between the viewing
platform and the image capturing device enables a series
of images to be captured.

5   7.   The method according to any one of claims 2 to 6,
wherein the fibres captured in the images are suspended in
a fluid to form a suspension of known volume.

       8.   The method according to claim 7, wherein the
10   method includes forming the suspension by mixing the
fibres in a fluid.

       9.   The method according to any one of claims 7 to
10, wherein a known volume of the suspension is in the
15   field of view of the image capturing device and thus
captured in the or each image.

       10.   The method according to claim 9, wherein the
ratio representing the total portion of fibres in the
20   sample to the average portion of fibre in the images is a
ratio of the total known volume of the suspension to the
volume of the suspension in the field of view of the image
capturing device.

25   11.   The method according to any one of claims 7 to
10, wherein the method includes conveying the suspension
past the image capturing device such that one or more
images of the fibres in the suspension can be captured.

30   12.   The method according to claim 11, wherein the
suspension is contained in a closed loop that extends past
the image capturing device so that the suspension can be
recirculated through the closed loop while the image(s)
are captured.

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13.   The method according to any one of claims 1 to 12, wherein the method also includes the step of weighing the sample of fibres selected for testing.

5   14.   The method according to any one of claims 1 to 13, wherein the fibre fineness of the fibres is estimated when the standard error of the mean value of measured fibre length per image determined in step b) is equal to or less than a preselected value.

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15.   The method according to claim 14, wherein the standard error be continuously recalculated after the capture of each image or a group of images to provide a running value of the standard error which may then be

15 continuously compared to the preselected value while the method is carried out.

16.   The method according to claim 15, whereby when the fibres being tested are of a known uniform length,

20 step b) involves counting the number of fibres in the image(s) using the automated computer image analysis.

17.   The method according to any one of claims 7 to 16, wherein an estimate of the fibre fineness is

25 calculated using the formula:

$$F = \frac{mv}{VL}$$

wherein F represents the average fibre fineness of
            the fibres in the images;

30   · m represents the total mass of the fibres
                        selected for testing;

            V represents the total volume of the fluid
                        suspension;

            v represents the volume of the suspension

35   captured in each image; and

    L represents the mean length of fibre in the images captured.

18.   The method according to any one of claims 7 to
5   17, wherein the fibre concentration appearing in the image(s) ranges up to 10.0 millimetres of fibre per square millimetre of image (mm/mm^2).

19.   The method according to claim 18, wherein the
10   fibre concentration in the image(s) ranges up to 2.0 mm/mm^2.

20.   The method according to any one of claims 7 to 19, wherein the image capturing device includes a chamber
15   through which the suspension is conveyed, the chamber having a transparent wall and the field of view of the image capturing device is directed at the transparent wall for capturing images of the fibres in the chamber.

20   21.   The method according to claim 20, wherein the cross-sectional area of the chamber transverse to the direction of flow of the suspension through the chamber vary such that the concentration of fibres captured in the image(s) can be adjusted by moving the position of the
25   field of view of the image capturing device along the chamber.

22.   The method according to claim 21, wherein the image capturing device is automatically adjusted along the
30   chamber depending on the fibre concentration appearing in the images.

23.   The method according to any one of claims 7 to 22, wherein the fibre concentration in the image(s) is
35   adjusted by changing the total volume of the fluid in which the fibres are suspended or the mass of fibres suspended in the fluid.

24.   The method according to any one of claim 7 to
23, wherein when the fluid of the suspension is a liquid,
the method further includes adding a wetting agent to the
5 liquid to improve the degree by which the fibres are
uniformly distributed in the suspension.

25.   The method according to claim 24, wherein the
wetting agent is a surfactant or an alcohol.

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26.   The method according to claim 24, wherein the
surfactant is a commercial cleaning detergent.

27.   The method according to claim 24, wherein the
15 surfactant is a non-ionic surfactant.

28.   The method according to any one of claims 1 to
27, whereby when the fibres being tested are cotton or
other cellulosic fibres, the method also includes
20 estimating the average maturity value using the estimated
fibre fineness from step c) and a micronaire value for the
sample of fibres.

29.   The method according to claim 28, whereby the
25 average maturity value is calculated by the following
equation:

$$F*M = 3.86*Mic^2 + 18.16*Mic + 13$$

30 wherein F is fibre fineness estimated in step c), M is
maturity and Mic is micronaire.

30.   An apparatus for estimating the fibre fineness of
a known mass of fibres, the apparatus including:
35   an image capturing device for capturing either i) all
of the fibres selected for testing or ii) a fraction
thereof, in one or more images;

a computer capable of automatically determining the
total length of fibre or fibres in the or each image; and
a means for estimating the fibre fineness of the
fibres using the total fibre length in the image(s).

31.   The apparatus according to claim 30, wherein the
means for estimating the fibre fineness is a computer that
can i) estimate the total length of fibre in the sample
and ii) divide the known mass of fibre in the sample by
the estimate of the total length of fibre in the image(s).

32.   The apparatus according to claim 31, wherein
when the image capturing device captures image(s) of the
fibres suspended in a substantially uniform fluid
suspension, the computer estimates the total length of
fibre in the sample by multiplying the mean length of
fibre in the image(s) by a ratio representing the total
fibre in the sample to the average portion of fibres in
the images.

33.   The apparatus according to claim 32, wherein the
computer is programmed to estimate the fibre fineness
using the formula:

$$F = \frac{mv}{VL}$$

wherein F represents the average fibre fineness of
                     the fibres in the images;
            m represents the total mass of the fibres
                     selected for testing;
            V represents the total volume of the fluid
                     suspension;
            v represents the volume of the suspension
                     captured by each image; and
            L represents the mean length of fibre in the
                     images captured.

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34.   The apparatus according to any one of claims 30
to 33, wherein the image capturing device is directly
linked to the computer for determining the fibre length in
5   the image(s).

35.   The apparatus according to any one of claims 30
to 34, wherein the apparatus includes a fluid passageway
that extends through a field of view of the image
10 capturing device such that when the fibres are suspended
in a fluid, images of the fibres can be captured as the
fluid is conveyed through the passageway.

36.   The apparatus according to claim 35, wherein the
15 passageway is in the form of a closed loop for
recirculating the fibres through the field of view of the
image capturing device.

37.   The apparatus according to claim 36, wherein the
20 apparatus includes a control means for controlling the
total volume of the suspension in the fluid passageway.

38.   The apparatus according to claim 37, wherein the
control means is provided by the fluid passageway being
25 flow connected to a head vessel, whereby maintaining the
fluid level in the head vessel ensures that the fluid
passageway contains a constant known volume of the
suspension.

30 39.   The apparatus according to claim 38, wherein the
fluid passageway includes a chamber that extends through
the field of view of the image capturing device including
a transparent wall so that the image capturing device can
capture images of the fibres passing through the chamber,
35 and the chamber is configured such that the volume of the
suspension in the field of view of the image capturing
device is known.

40.   The apparatus according to claim 38, wherein the cross-section of the chamber in a direction transverse to the direction of flow through the chamber is graduated
5   such that the volume of fluid in the field of view of the image capturing device varies along the chamber.

41.   The apparatus according to claim 40, wherein the depth of the chamber in a direction transverse to the
10   direction of flow through the chamber tapers continuously between the inlet and outlet of the chamber.

42.   The apparatus according to claim 40 or 41, wherein the cross-sectional area of the chamber transverse
15   to the direction of flow through the chamber can be varied by actual movement of one wall of the chamber relative to another wall.

43.   The apparatus according to claim 40, wherein the
20   position of the field of view of the image capturing device is moveable along the chamber so that the volume of suspension in the field of view can be varied.

44.   The apparatus according to claim 43, wherein the
25   apparatus includes a drive assembly for adjusting the position of the image capturing device relative to the chamber.

45.   The apparatus according to claim 44, wherein a
30   computer for operating the drive assembly is programmed so that it can determine the volume of suspension passing the field of view of the image capturing device.

46.   The apparatus according to claim 44 or 45,
35   wherein the computer for operating the drive assembly automatically operates the drive assembly and thereby adjusts the position of the image capturing device when

the fibre concentration in the image fall outside a
selected range.

47.   The apparatus according to claim 46, wherein the
5   selected range is from 0 to 10 mm of the fibre per square
mm of image.

48.   The apparatus according to claim 47, wherein the
selected range is from 0 to 2mm of fibre per square mm of
10   image.

49.   The apparatus according to any one of claims 30
to 47, wherein the image capturing device includes a
recording device that can record images in a digital
15   format.

50.   The apparatus according to any one of claims 44
to 49, wherein the image capturing device also includes an
illuminating means to assist in the capture of images of
20   the fibres.

51.   The apparatus according to claim 50, wherein the
illuminating means includes a light source positioned on
the opposite side of the chamber to the recording device
25   such that light transmitted through the fibres can be
detected by the recording device.

52.   The apparatus according to claim 51, wherein the
illuminating means includes a light source on the same
30   side of the chamber as the recording device such that
light reflected from the fibres can be detected by the
recording device.

53.   The apparatus according to any one of claims 50
35   to 52, wherein the illuminating means is moveable relative
to the chamber such that when the image capturing means is
moved relative to the chamber, the illuminating means is

able to remain in a relatively fixed position compared to the image capturing device.

54.   The apparatus according to any one of claims 44 to 53, wherein the illuminating means is moveable by the drive assembly for moving the image capturing device.